Classification of materials

We learned in the previous class

- ✓**Introduction to Classification of materials**
- ✓**Type of matter**

CONCENRATION TERMS

Concentration is a very common concept used in chemistry and related fields. It is the measure of how much of a given substance there is mixed with another substance. This can apply to any sort of chemical mixture, but most frequently is used in relation to solutions, where it refers to the amount of solute dissolved in a solvent. **To concentrate a solution, one must add more solute, or reduce the amount of solvent (for instance, by selective evaporation).** By contrast, to dilute a solution, one must add more solvent, or reduce the amount of solute. There exists a concentration at which no further solute will dissolve in a solution. At this point, the solution is said to be saturated. If additional solute is added to a saturated solution, it will not dissolve. Instead, phase separation will occur, leading to either coexisting phases or a suspension. The point of saturation depends on many variables such as ambient temperature and the precise chemical nature of the solvent and solute. **Concentration may be expressed both qualitatively (‘informally’) and quantitatively (‘numerically’).**

1. Qualitative notation: Qualitatively, solutions of relatively low concentration are described using adjectives such as **“dilute,” or “weak,”** while solutions of relatively high concentration are described as **“concentrated,” or “strong.”** As a rule, the more concentrated a chromatic solution is, the more intensely coloured it is.
These glasses containing red dye demonstrate qualitative changes in concentration. The solutions on the left are **“weaker”** (or more dilute), compared to the **“stronger”** (or more concentrated) solutions on the right.

2. Quantitative notation: Quantitative notation of concentration is far more informative and useful from a scientific point of view. There are a number of different ways to quantitatively express concentration; the most common are listed below.
Note: Many units of concentration require measurement of a substance’s volume, which is variable depending on ambient temperature and pressure. Unless otherwise stated, all the following measurements are assumed to be at standard state temperature and pressure (that is, 25 degrees Celsius at 1 atmosphere).

Concentration of a Solution

The concentration of a solution is the amount of solute present in a given quantity of the solution.

The solution having small amount of solute is called Dilute Solution.

The solution having large amount of solute is called Concentrated Solution.

The concentration of a solution is defined as mass of solute in grams present in 100 g of the solution.

For example:10% solution of NaCl (10 g of NaCl + 90 g of water)

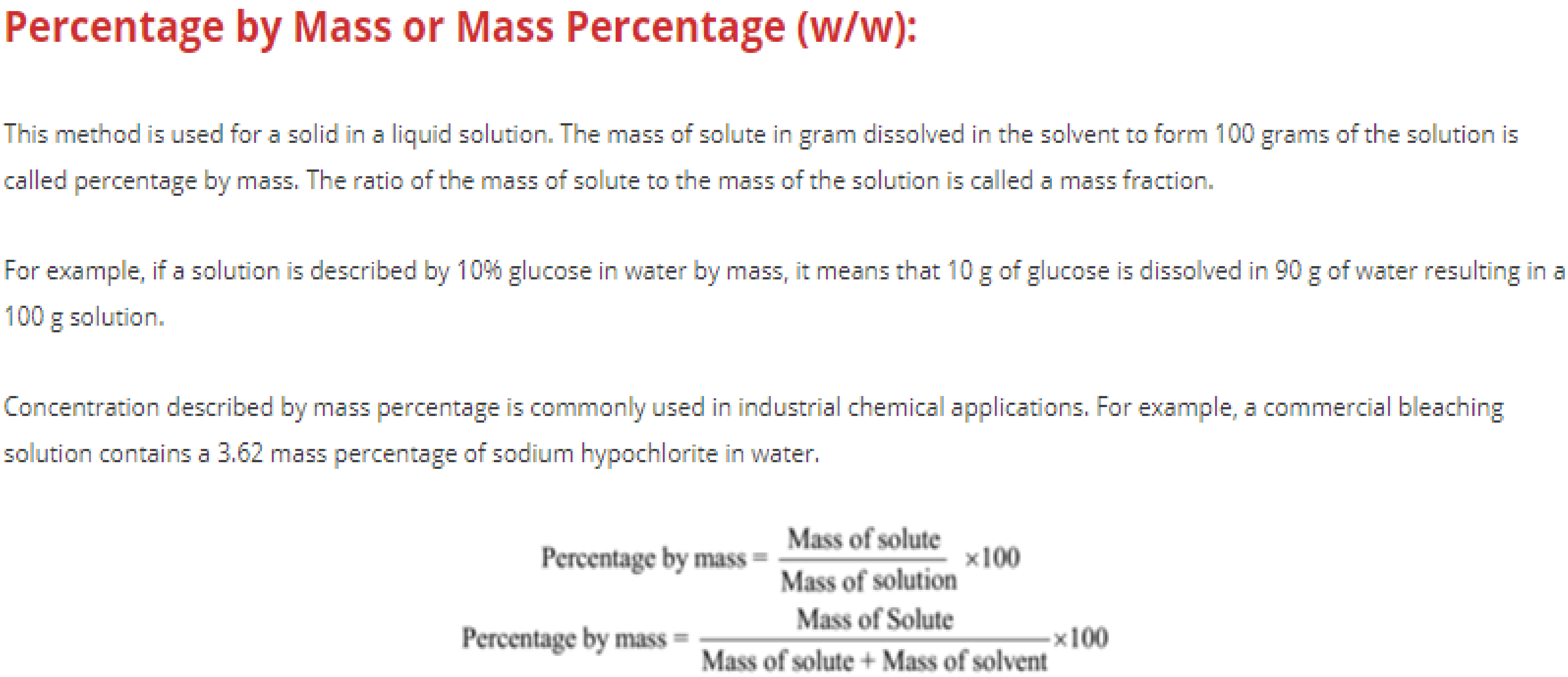
The amount of solute dissolved in a given mass or volume of solvent.

Concentration of solution = (Amount of solute)/ (Amount of solution)

Methods of Expressing the Concentration of a Solution

The concentration of a solution can be expresses in a number of ways. The important methods are:

1. **Mass percent**
2. **Volume percent**
3. **Mass/Volume percent**
4. **Molarity**
5. **Normality**
6. **Formality**
7. **Molality**
8. **Mole fraction**



Percentage by Mass or Mass Percentage (w/w):

This method is used for a solid in a liquid solution. The mass of solute in gram dissolved in the solvent to form 100 grams of the solution is called percentage by mass. The ratio of the mass of solute to the mass of the solution is called a mass fraction.

For example, if a solution is described by 10% glucose in water by mass, it means that 10 g of glucose is dissolved in 90 g of water resulting in a 100 g solution.

Concentration described by mass percentage is commonly used in industrial chemical applications. For example, a commercial bleaching solution contains a 3.62 mass percentage of sodium hypochlorite in water.

$$\text{Percentage by mass} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$\text{Percentage by mass} = \frac{\text{Mass of Solute}}{\text{Mass of solute} + \text{Mass of solvent}} \times 100$$

Question:

A solution contains 40 g of common salt in 320 g of water. Calculate the concentration in terms of mass by mass percentage of the solution

Solution

Mass of solute (salt) = 40 g

Mass of solvent (water) = 320 g

Also, Mass of solution = Mass of solute + Mass of solvent

= (40 g + 320 g)

= 360 g

Mass percentage of solution= [(Mass of solute)/ (Mass of solution)] ×100

= (40/360) ×100 =11.1%

Question:

What is the weight percentage of urea solution in which 10 gm of urea is dissolved in 90 gm water.

Solution

Mass of solute (urea) = 10 gm

Mass of solvent (water) = 90 gm

Also, Mass of solution = Mass of solute + Mass of solvent

= (10 gm + 90gm)

= 100 gm

Mass percentage of solution= [(Mass of solute)/ (Mass of solution)] ×100

= (10/100) ×100 =10% urea solution

Percentage by Volume (V/V):

This method is used for liquid in a liquid solution. For example, a 10% ethanol solution in water means that 10 mL of ethanol is dissolved in 90 mL water such that the total volume of the solution is 100 mL.

$$\text{Percentage by volume} = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

$$\text{Percentage by volume} = \frac{\text{Volume of Solute}}{\text{Volume of solute} + \text{Volume of solvent}} \times 100$$

Percentage by Mass by Volume (w/V):

It is the mass of solute dissolved in 100 mL of the solution. This method is commonly used in medicine and pharmacy.

$$\text{Percentage mass by volume} = \frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$$

Question:

In a solution, there is 111.0 mL (110.605 g) solvent and 5.24 mL (6.0508 g) solute present in a solution. Find the mass percent, volume percent and mass/volume percent of the solute.

Solution

Mass Percent

=(Mass of Solute) / (Mass of Solution) x 100%|

=(6.0508g) / (110.605g + 6.0508g) x 100%

=(0.0518688312) x 100%

=5.186883121%

Mass Percent= 5.186%

Volume Percent

=(Volume of Solute) / (Volume of Solution) x 100%

=(5.24mL) / (111.0mL + 5.24mL) x 100%

=(0.0450791466) x 100%

=4.507914659%

Volume Percent= 4.51%

Mass/Volume Percent

=(Mass of Solute) / (Volume of Solution) x 100%

=(6.0508g) / (111.0mL + 5.24mL) x 100%

=(0.0520) x 100%

=5.205%

Mass/Volume Percent= 5.2054%

Practice questions:

1. If 110g of salt is present in 550 g of solution, calculate the concentration.
2. What is the concentration of a solution which contains 16 g of urea in 120 g of solutions?
3. How much water should be added to 15 g of salt to obtain 15% salt solution?
4. A solution contains 5.6 ml of alcohol mixed with 76 ml of water. Calculate the concentration of the solution.
5. How much water should be added to 12 ml of alcohol to obtain 12% alcohol solution?
6. If 25 ml of acetone is present in 150 ml of its aqueous solution, calculate the concentration.

Answers

1. 22%
2. 13.33%
3. 100 ml
4. 6.8627%
5. 88 ml
6. 16.66%

Things to do………..

- Revise **type of matter and solution.**
- **Solve Exercise#1 Advance module: (1- 26)**
- **Solve Exercise#1 Foundation module: (1-13)**
- Solve **Exercise# 2**

➢**Very short answer type questions (1-10)**

➢**Short answer type questions (1-9)**

➢**Long answer type questions (1-5)**